
Vladimir Borek and David Ziff
Department of Geological Sciences
The University of Texas at San Antonio

Abstract

The purpose of this study was to identify land change trends in Bexar County, Texas by use of data obtained from the MRLC (Multi-resolution Land Characteristics Consortium) and MSA (Metropolitan Statistical Area). Additionally, overall county land change was compared to subsets within Bexar County to assess any trends in the spatial data presented.

Introduction and Background

San Antonio is the second largest city in the state of Texas. Population growth for San Antonio between 2000 and 2005 was at 9%, with a population of 1,518,370. In 1970, the majority of the population resided within loop 410 and growth began to trend towards the north side. In 1980 the Population moved outside the Loop; predominately towards the North Central and Northeast. In 1990, the growth trended towards the Northwest and in 2000 this momentum continued and pushed outside the envelope of 1604. Growth estimates for 2010 project continued growth outside 1604, the 281 and I-10 corridors and to the west. Expected growth rates can be seen in Table 1, San Antonio City Growth annex.

This population growth pattern is predicated on the automobile. Without such, the community would be dysfunctional. In a time which is faced with the increased threat of fuel shortages, this type of growth is unsustainable. While such trends continue to pad the pockets of developers, the growth does not enhance the quality of life for the greater community of San Antonio. Many efforts have been made by the planning department. However, with the vast majority of members of the zoning and planning commission not having intellectual backgrounds in the field of planning, there is little vision or understanding of contemporary planning theories and success. In the end, progressive measures are vetoed or avoided via the use of variances or vested rights.

The City of San Antonio has grown extensively through annexation. The City consisted of merely 36 square miles in 1937. From 1940 to 1950 the city grew by an additional 70 square miles. During the early 50s, the City annexed another 161 square miles in the region now known as loop 410. Before 2000, the city did not undertake annexation South of Loop 410. The new area is approximately 21 square miles; created to include the Toyota Motor Manufacturing site.

The City of San Antonio only appears to annex as much land as is beneficial to the city to contain on a strictly tax basis…
Table 1. San Antonio Area Growth by Annexation: 1937 - 2006

Land use data from remotely sensed images can be used to identify the type of land change over a certain time frame. The land change data cannot provide a context of why land is changing the way it is. One obvious reason for land change is population growth, but the data cannot let the user know if land is changing for that reason alone. In order to put the land change data into context, the remotely sensed data was broken down and analyzed for types of land change on a county and city level, and compared with county and city statistics to establish trends and correlations between the two data sets.

To this end, two datasets were used. The first dataset was obtained from the Multi-Resolution Land Characteristics Consortium (MRLC), and contained land use change data between 1992 and 2001. Landsat Thematic Mapper satellite data was purchased for use as the 1992 data set. This data includes a 21-class land cover classification scheme mapped consistently over the United States using unsupervised clustering and GIS modeling (MRLC website). 2001 MRLC data was obtained from LANDSAT 7 imagery. The comprehensive land cover database is created from these imagery sets and classifications are assigned based on regional and MRLC Classification codes that can be seen in Table. 2.
<table>
<thead>
<tr>
<th>Modified</th>
<th>Class Codes and Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Data</td>
</tr>
<tr>
<td>1</td>
<td>Open Water - All areas of open water, generally with less than 25% vegetation or soil cover. Pixels coded to a value of 1 have not changed between 1992 and 2001.</td>
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<tr>
<td>2</td>
<td>Urban - Includes developed open spaces with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses such as large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. Also included are lands of low, medium, and high intensity with a mixture of constructed materials and vegetation, such as single-family housing units, multifamily housing units, and areas of retail, commercial, and industrial uses. Pixels coded to a value of 2 have not changed between 1992 and 2001.</td>
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<tr>
<td>3</td>
<td>Barren - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover. Pixels coded to a value of 3 have not changed between 1992 and 2001.</td>
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<tr>
<td>4</td>
<td>Forest - Areas dominated by trees generally taller than 5 meters, and greater than 20% of total vegetation cover. Includes deciduous forest, evergreen forest, and mixed forest. Pixels coded to a value of 4 have not changed between 1992 and 2001.</td>
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<td>5</td>
<td>Grassland/Shrub - Includes grassland areas dominated by gramminoid or herbaceous vegetation and shrub/scrub areas dominated by shrubs less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation, including true shrubs, young trees in an early successional stage, or trees stunted due to harsh environmental conditions. Management techniques that associate soil, water, and forage-vegetation resources are more suitable for rangeland management than are practices generally used in managing pastureland. Some rangelands have been or may be seeded to introduced or domesticated plant species. Includes those areas in the Eastern United States that commonly are called brushlands. Pixels coded to a value of 5 have not changed between 1992 and 2001.</td>
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<tr>
<td>6</td>
<td>Agriculture - including cultivated crops and pasture/hay – Cultivated crops are described as areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. This class also includes all actively tilled land. Pasture/Hay is described as grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pixels coded to a value of 6 have not changed between 1992 and 2001.</td>
</tr>
<tr>
<td>7</td>
<td>Wetlands - including woody wetlands and herbaceous wetlands – Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water. This class also includes areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water. Pixels coded to a value of 7 have not changed between 1992 and 2001.</td>
</tr>
<tr>
<td>8</td>
<td>Ice/Snow - All areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover. Pixels coded to a value of 8 have not changed between 1992 and 2001.</td>
</tr>
</tbody>
</table>

Table 2. Land Change Classification Codes (MRLC)

Data Limitations:

There are some limitations of the remotely sensed data, which could potentially misidentify the correlations between county statistics and land change. The land change data was created using classified images from 1992 and 2001. Data collected in 1992 and 2001 was sufficiently different in classification that the two datasets had to be adjusted to be useful for comparison.

The adjustment of the land use data was performed in two steps. First, the original land classifications were collapsed into coarser classes, so the two datasets could be compared. The datasets were reclassified into nine different classes, numbered from zero to eight (single digit values), where zero represents no data, and one through eight represent all the different land use
types (Table 2). Second, a pixel by pixel comparison was performed, and the resulting output was reclassified again into new classes. Where pixel values from dataset one matched dataset two, this represented no change in land use, and the pixel value was retained in the output. Where pixel values from set one and set two did not match, a new value was created by combining value one and two. The resulting output was a two digit number representing from and to change. For example, the land use change from forest to urban would be classified as 42.

The changes made to the datasets, although useful for comparing data, do limit what information can be extracted. Many of the classes have been lumped together, which could introduce error and over-generalize the information.

**Methods**

In order to identify correlations between land change data obtained from the MRLC with data from the MSA, the MRLC data was broken down and extracted for Bexar County and San Antonio City Limits. The San Antonio’s ArcIMS service was used to download clipped shapes for Bexar County, and the city limits. Using ArcGIS, the data obtained from MRLC was clipped to the area of interest. The resulting coverage values were then exported into Excel spreadsheets for further analysis.

Data for the county and city was divided into unchanged and changed area, so that statistics could be derived. Once the data was broken down, graphs were generated showing the percentage of changed and unchanged land, all divided into land use types. The data for superzone 10 (encompasses Bexar County) of the MRLC land change dataset was downloaded into ArcGIS, and then clipped to three areas of interest. The areas of interest used were Bexar County, San Antonio city limits, and the Edwards Aquifer recharge zone. Shapefiles of the corresponding boundaries were downloaded from the San Antonio ArcIMS server. From the ArcToolbox, a clip analysis tool was used to extract data for Bexar County, The San Antonio city limits, and the Edwards Aquifer recharge zone. The datasets were added into an ArcGIS session, and their attribute tables were exported as comma delimited files to be used in Microsoft Excel.

In Microsoft Excel, the data was modified for further analysis. As the pixel count values represent a 30 meter squared area, a square meter area was calculated (Area in squared meters = count * 900). Next the square meter area was recalculated into acres (Acres = area in square meters * 0.000247105381). These steps were performed for each clipped attribute table output.

The areas covered by each class were then converted into a fraction value of the total area of interest (Fraction Area = (Area / Total Area)*100). The resulting fraction values were used for graphical comparison against the total changed and unchanged area.
Results and Expected Population Growth Trends

Results of MRLC Data Analysis:

The following graphs represent the results of the attribute data analysis performed on MRLC datasets for Bexar County, the San Antonio city limits, and the Edwards aquifer recharge zone. Within Bexar County, 88 percent of the land remained unchanged (Graph 1). The unchanged area of Bexar County is predominantly made up of forests, urban areas, and grassland/shrub (Graph 2). Of the changed land in Bexar County, highest percent change occurred from forested areas to grassland/shrub, urban, and agriculture (Graph 3).
Land Use trends within the San Antonio city limits

Within the San Antonio city limits, same land use trends were observed as on the county level. Eighty-eight percent of land remained unchanged (Graph 4), majority of which is made up of urban areas, along with forest and grassland/shrub (Graph 5). As on the county level, most of the changes within the city limits were from forested areas. However, the change within the city limits is more diversified than on the county level. Most of the change within the city was from forest to urban areas, followed by changes from forest to grassland/shrub and grassland/shrub to urban (Graph 6). This suggests urban growth as land is converted to make room for new development.

![Land Use Trends within San Antonio City Limits](graph4.png)
Unchanged Area (>1%) Breakdown within San Antonio City Limits

- Urban: 64%
- Forest: 17%
- Grassland/Shrub: 13%
- Agriculture: 4%
- Wetlands: 2%

Changed Area (>1%) Breakdown within San Antonio City Limits

- Forest to Urban: 20%
- Forest to Barren: 6%
- Forest to Grassland/Shrub: 6%
- Forest to Agriculture: 6%
- Forest to Wetlands: 2%
- Grassland/Shrub to Urban: 6%
Land Use trends within the Edwards Aquifer

Although most of the Edwards Aquifer recharge zone remained unchanged, we see that there is a slightly higher percentage in changed land than on the county or city level (Graph 7). The Edwards Aquifer recharge zone is made up of only three land use types, dominated by forest areas, followed by urban and grassland/shrub (Graph 8). The change occurring within this area is also more diversified, but majority occurs in forest conversion to urban and grassland/shrub uses, along with grassland/shrub to urban (Graph 9). This also suggests that land is being converted for the use of urban expansion.
Unchanged Area (>1%) within Edwards Aquifer

Area Changed (> 1%) Breakdown within Edwards Aquifer
Results of MSA Data for San Antonio:

Projected Population Growth by County: 2050

Bandera
Pop. 56,640
221%

Medina
Pop. 75,370
92%

Kendall
Pop. 89,310
276%

Comal
Pop. 278,636
257%

Guadalupe
Pop. 252,860
184%

Wilson
Pop. 106,370
228%

Atascosa
Pop. 69,320
80%

Source: US Census

Projected Population Growth by County: 2050
The population growth is shown by county from 2000 – 2005 based on the Metropolitan Statistical Area (MSA) for San Antonio and all counties with adjacency to Bexar County. Within this area, over 68,000 people commute on a daily basis into Bexar County for employment. (Moncivais, 2006).

The growth within the San Antonio City limits is dismal. With the abundance of built and unused terrain, it is unfortunate and irresponsible to allow such unchecked growth outside of the city limits. There has been no attempt by the state or the county to create any type of Urban Growth Boundary for the area; for any area in Texas for that matter. Due to the low cost of new construction, it has been deemed more cost effective and profitable for developers to develop previously undeveloped land than to redevelop areas which have been previously utilized within the urban environment. This type of psychology lends itself to the furthermost of blight and thus higher crime rates in areas in need of redevelopment.
The existing Metro area is projected to grow by 93% by 2050 while the county itself only expresses a growth of 70% in total. To the north, Kendall County will express largest percentage growth; projected at 276% (Moncivais, 2006).

As mentioned before, San Antonio’s unrestricted growth is clearly seen above. Many of the greatest assets within the San Antonio region are being lost due to lack of control by the state and local government. The furthest extent of the Texas Hill Country is found in Bandera Medina County. This area is surely to be lost absent of regulation. It is impossible to expect the market to regulate itself. Bandera’s growth rate of 221% by 2050 is unwarranted; the urban hub is San Antonio and not the hill country.

**Housing Production 1986 – 2005**

The housing market previously peaked in the mid 80s. The most recent housing cycle began in 1991 and is ending now (2008-2009); the largest spike was seen in 2005. The national housing lagged in Texas because of the low price of new homes (Moncivais, 2006).

The housing market of the mid 80s was fueled by the S&L crises. However, due to the fact that San Antonio is absent a major international hub airline, the crisis in the 80s did not affect San Antonio as much as Dallas and Houston. However, San Antonio is expressing the same growth trends as
Dallas and Houston with only lower slope on the growth curve. The land use trends in San Antonio currently mirror those of Dallas and Houston from the early 70s.

It is expected, as San Antonio grows, the highs and lows realized within the housing cycle will continue to become more similar to those of Dallas and Houston. Such a Boom & Bust approach to growth is fraught with error and shortsightedness. It will take major changes in State and Local governments in order to curb such trends.

**Land Use & Development Trends**

Land is purchased with by real estate investors and held only for appreciation and equitable gains. The majority of these investors sell to developers prior to development. The monies from the sales are funneled through 1031 Exchanges to avoid paying Capital Gains; this money is reinvested in raw land.

In San Antonio, the Tree Ordinance coupled with Vested Rights, has caused the vast majority of land sales to include the deforestation of properties prior to sale. This is done because the seller has the right to cut indiscriminately while the purchaser does not retain such a right. Therefore, land is deforested prior to sale.

In order to avoid paying commercial tax rates on property, developers maintain Agricultural Deferments on their properties until the time of development. Therefore much of the property being deforested is then used for ‘agricultural purposes.’

In this way we see a trend of land holding being deforested, turned to grass and shrub land and then developed at a later date. All this is done with the ‘highest and best use’ of the land in mind. There appears to be some serious disagreement concerning the definition of ‘highest and best use’.

**Conclusions**

Land change data provided by the Multi-Resolution Land Characteristics Consortium (MRLC) provides data about the changes which occurred in the landscape between 1992 and 2001. This land change data roughly corresponds to the census data which is released every decade (1990 and 2000). Given that the data from both the MSA and the MRLC are released around the same time, it is our conclusion that majority of the changes which have taken place are due to the rapid increase in population and the expansion of the city throughout Bexar County.
References / Sources

